

INCREASING THE RATE OF PRESENTATION AND USE OF SIGNALS
IN ELEMENTARY CLASSROOM TEACHERS¹

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Two issues relevant to competency-based teacher training were investigated—the specification of acceptable implementation levels for validated techniques and the necessity and feasibility of providing training on those techniques. First, a descriptive study was conducted to collect data on two direct-instruction teaching techniques—rate of presentation and signalling—that have been demonstrated to be functionally related to child performance in earlier studies. Data collected on 13 teachers, who received intensive preservice and inservice training, were then used as a standard for comparison in a multiple-baseline design across three untrained teachers to evaluate the effects of training on the two techniques. The experimental study served to determine whether training on the two techniques was necessary; and, if training was necessary, whether a training package, including supervised practice, unsupervised practice, and self-critique, would result in adequate implementation levels for the two techniques. Low implementation levels during baseline for three untrained teachers indicated that training was necessary. With training, all teachers increased their levels of appropriately signalling pupil responses and accelerated their rates of presentation well above the levels of the comparison standard. Observations made one week and again four weeks after training ended showed that performance levels achieved during training were maintained.

DESCRIPTORS: teacher behavior, inservice training, rate of presentation, antecedent events, signals, teacher trainees

Recent legislative and social emphasis on effective educational approaches has stimulated considerable research into instructional variables that contribute to academic achievement. In a recent literature review on classroom teaching of reading and math to primary-grade students from poor families, Rosenshine (1976) reported that instruction time, content covered, composi-

tion of work groupings, type of teacher questions, type and number of student responses, and adult feedback are variables that correlate positively with achievement. Rosenshine labelled the procedures associated with academic achievements as the direct instruction model (sometimes called a structured approach). The recent evaluation of Follow Through, the largest educational experiment ever conducted, supports these conclusions.

Abt Associates (1976), in reporting on 4-yr Follow Through effects, stated that the DISTAR direct instruction model has largely achieved the goal of raising the average achievement of economically disadvantaged Follow Through children to a level comparable to that of their middle-class peers. These results are consistent with other reports on Follow Through data (Battman and Carnine, 1977; McDaniels, 1975; Stallings, 1975) as well as evaluations conducted in

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other settings (Kim, Berger, and Kratochirl, 1972; Science Research Associates, 1971). While these findings support the general effectiveness of the direct instruction model with respect to teaching academic skills to economically disadvantaged children, examination of the specific components responsible for the desired outcomes is just beginning.

A formative analysis, or process research program, has been initiated within the context of the DISTAR direct instruction model (Carnine, 1976; Cowart, Carnine, and Becker, Note 1; Siegel, 1977). The results suggest that several direct instruction techniques, such as the use of signals for eliciting group responses and rapid pacing of teacher questions, are functionally related to children's academic performance in the primary grades. Signals are considered valuable in group instruction because they may serve as discriminative stimuli and increase the occurrence of attending and responding. Teachers also use signals to delay responses from higher-ability children until slower children have time to formulate an answer. This delay allows all students to initiate a response, not just the higher-performing students.

Cowart *et al.* (Note 1) evaluated signals following an ABAB design with three groups of students. The first group consisted of three preschoolers who received small-group instruction. When signals were used, 89% of the tasks (combined across both signal phases) were responded to as a group; when signals were not used, the per cent dropped to 60. Mean attending was 82% with signals and 57% without signals. In the other two groups, second graders received instruction as an entire class rather than in small groups, and signals were less critical. The combined mean for responding (both groups across both signal phases) was 81% with signals and 64% without signals. The combined mean for attending was 55% with signals and 39% without signals. Siegel (1977), and Siegel and Rosenshine (Note 2), reported that the use of signals for group responses in small-group instruction was positively correlated with student achieve-

ment. In one study involving 10 groups of five students each, the partial correlation between the use of signals and student performance on a criterion-referenced test was 0.83. In the second study involving 24 groups, the partial correlation was 0.67. Both correlations were significant at the 0.005 level.

Rapid pacing (rate of presentation) not only increases the quantity of material that can be taught in a given period, but also maintains child attention to the instructional stimulus. Carnine (1976) compared slow and rapid rates of teacher question asking in small-group reading instruction and found that a rapid presentation (minimizing the elapsed time between questions) resulted in less disruptive behavior and a larger percentage of correct letter and word identifications.

Before research findings such as these may be used to design competency-based teacher training programs, adequate levels of technique implementation must be described (and quantified) and procedures for training teachers to achieve those levels must be established. Rather than using the implementation levels from the previous studies as criteria, a comparison standard based on teachers in training was selected as being more representative of implementation that might be achieved in practice. Thus, in the first study, data were collected on classroom teachers who had just received intensive preservice training and were currently engaged in inservice training in the direct instruction approach. These data provided a standard of comparison for evaluating the necessity for and the effect of training in an experimental study with additional teachers.

The present evaluation model was an adaptation of the model used by Walker and Hops (1976), in which peer data were used as a standard for evaluating treatment effects on children who exhibited low levels of appropriate classroom behavior during baseline. By establishing a quantitative standard, the experimenters were able to evaluate treatment effects, not only in terms of changes within the treated subjects, but

also in terms of the magnitude of those changes; *i.e.*, did the treatment result in the subjects exhibiting an adequate level of appropriate classroom behavior? Similarly, in the present descriptive study, data on implementation levels provided a standard of comparison for the evaluation of the magnitude of changes that occurred as a result of the training conducted during the experimental study. Without such standards, the evaluation of the behavioral significance of an increase in the targeted teacher behavior becomes arbitrary.

The teacher-training procedures in the present studies were also used in earlier studies (Horton, 1975; Rule, 1972; Saudargas, 1972; Thomas, 1971). The present training focus was on events antecedent to pupil responses, rather than on consequent events. A demonstration of the effectiveness of the teacher-training procedures that modify antecedent events would extend the generalizability of the training procedures.

In summary, the descriptive study and the experimental study were designed to answer two questions. First, what is the classroom standard or level of implementation for the signalling and rate of presentation techniques? Second, is training (beyond reading the teacher manual) necessary and, if so, functionally related to naive teachers reaching those implementation levels?

DESCRIPTION OF A STANDARD FOR COMPARISON

METHOD

Subjects

Thirteen students enrolled in teacher-training programs at the University of Oregon served as teacher trainees. The program included practicum training in the use of the DISTAR instructional materials for teaching reading, arithmetic, and language, and the teaching techniques associated with those direct instruction systems. None of the teacher trainees had previous teaching experience with the programmed materials or the specific teaching techniques.

SETTING

The trainees taught small instructional groups of five to 10, first- or second-grade children in public-school classrooms. Engelmann-Becker Follow Through staff, who were trained in the supervision and use of the DISTAR materials, supervised the teacher-trainees. Typically, the instructional setting consisted of the children seated in chairs, in a semicircle, facing the teacher-trainee.

Materials

The DISTAR materials used in instruction included the teacher presentation books from Reading I, Reading II, Arithmetic I, Arithmetic II, and Language I, and the individual worksheets that accompanied each of the lessons in the reading and arithmetic programs (Engelmann and Bruner, 1974; Engelmann and Carnine, 1975; Engelmann, Osborn, and Engelmann, 1970).

Training Procedures

The training procedures consisted of two mornings of preservice workshops and continuous inservice training. During the preservice workshops, the programs were described, the programming rationale given, and the teachers role-played teaching the programs. During the role-playing practice, teachers were instructed on critical teacher behaviors, such as reinforcement techniques, use of signals, maintaining acceptable rates of presentation, and small-group management procedures.

Setting

The inservice training consisted of two components: (a) inservice workshops, and (b) supervisor observation. The inservice workshops were conducted once each week and included activities to prepare the teachers for upcoming changes in the teaching formats, advanced direct instruction skills, and individualized training focusing on the special needs of individual teachers. (For the preservice, inservice, and supervisor

observation procedures, see the training manual by Carnine, Witcher, and Haddox, Note 3.)

Typically, the supervisors observed each of the teachers in the classroom setting twice each week. These sessions allowed the supervisor to observe each teacher and to demonstrate techniques that the trainee needed to use. At the end of the observation session, the supervisor provided the teachers with a written assessment of their performance, which included a written prescription for specific skill deficits.

Measurement

The mean number of seconds per task and the per cent of appropriate signals were the dependent variables.

Trained observers collected data on each teacher-trainee at least twice each week, at times when the teacher's supervisor was not present. Observers positioned themselves for a clear view of the children and the teacher by usually sitting to the front and one side of the group. Since the classrooms were frequented by visitors as well as by the supervisors, the children were accustomed to being observed.

At the beginning of each observation session, the observers completed the information at the top of the rating form, carefully noting the time when the teacher-trainee initiated the first teacher presentation unit. An event-recording method was used to record the occurrence of a task and the occurrence of an appropriate signal. As in the Carnine study (1976), a teacher presentation unit or task was defined as the following temporal sequence of events:

1. The teacher-trainee presented the appropriate stimulus material either verbally or by holding the stimulus in view of the children in the group.
2. At least one child emitted a task-appropriate verbal or motor response (or all of the children failed to respond) in the presence of the stimulus.
3. The teacher-trainee consequated the response either with social reinforcement, a

correction procedure, or by initiating the next teacher presentation unit.

At the end of the observation session, observers recorded the elapsed time for the session (the time between initiation of the first teacher-presentation unit and completion of the last teacher-presentation unit). The elapsed time (in seconds) of the observation session was divided by the number of tasks recorded to provide a measure of rate of presentation (seconds per task). Sessions were designed so that students did not leave the group during instruction, nor did other students intrude.

During each observation session, the observers also recorded the occurrence of each appropriate signal for the group to respond. When the task required the teacher to signal the children's response with a hand signal, the signal had to be made in a clear crisp motion, allowing approximately 1 sec between initiation of the signal and its completion. In cases where hand signals were not appropriate for the task (*e.g.*, when the teacher was using both hands or the children were reading and could not watch for a hand signal), the teacher used voice inflection to signal for responses. If the teacher initiated a signal that did not meet the above criteria, it was scored as an inappropriate signal.

Interobserver reliability was assessed on 76 different occasions. Since each teacher-presentation unit or task represented an opportunity to observe an appropriate or an inappropriate signal, the reliability of the observers on the appropriate signals measure was calculated by dividing the total number of teacher-presentation units where the observers agreed that an appropriate signal occurred by the sum of the units where the observers agreed and the units where the observer disagreed, multiplying the quotient by 100. Reliability of the rate-of-presentation measure (seconds per task) was calculated as in the earlier Carnine (1976) study: a Pearson *r* was calculated for the seconds per task as calculated from each observer's recordings each session. Mean interrater reliability was 84% for ap-

appropriate signals, and $r = 0.90$ for seconds per task.

RESULTS AND DISCUSSION

Figure 1 shows the mean per cent of all signals that were recorded as appropriate signals, averaged across the four to seven teacher-trainees observed each session, after the preservice training workshop (a period of about nine weeks). Figure 2 shows the mean number of seconds per task, averaged across the same trainees, for the same session. The teacher-trainees averaged 73.5% appropriate signals and 8.53 sec per task. These data, when compared to those reported by other experimenters who have investigated the effects of direct instruction techniques on child performance (Carnine, 1976; Cowart *et al.*, Note 1), represent a moderate level of implementation; *e.g.*, closer to the 5.0 rapid rate in the Carnine study (1976) than the 14.2 slow rate.

A closer inspection of the data reveals an outlier in the per cent of appropriate signals (Figure 2). The data point for the first session indicates an absence of appropriate signals. This

data point is probably unrepresentative, in that the teachers were being observed the first time they taught, they were being introduced to other personnel in the classroom, to the students, and to the schedule, and the observers were being introduced into the classroom. Other than the data point for this atypical session, the signalling data were fairly consistent over time. The rate of presentation data indicates a slight trend toward a more rapid presentation, which would be expected as the teachers became acclimated to the program and the classroom.

TRAINING STUDY

METHOD

Using the levels of implementation described in the prior study as a comparison standard, a second study was designed to examine procedures for training a teacher and two aides to achieve these levels of implementation for appropriate signals and rate of presentation.

Subjects

One classroom teacher and two classroom aides, who had not been trained in the DISTAR

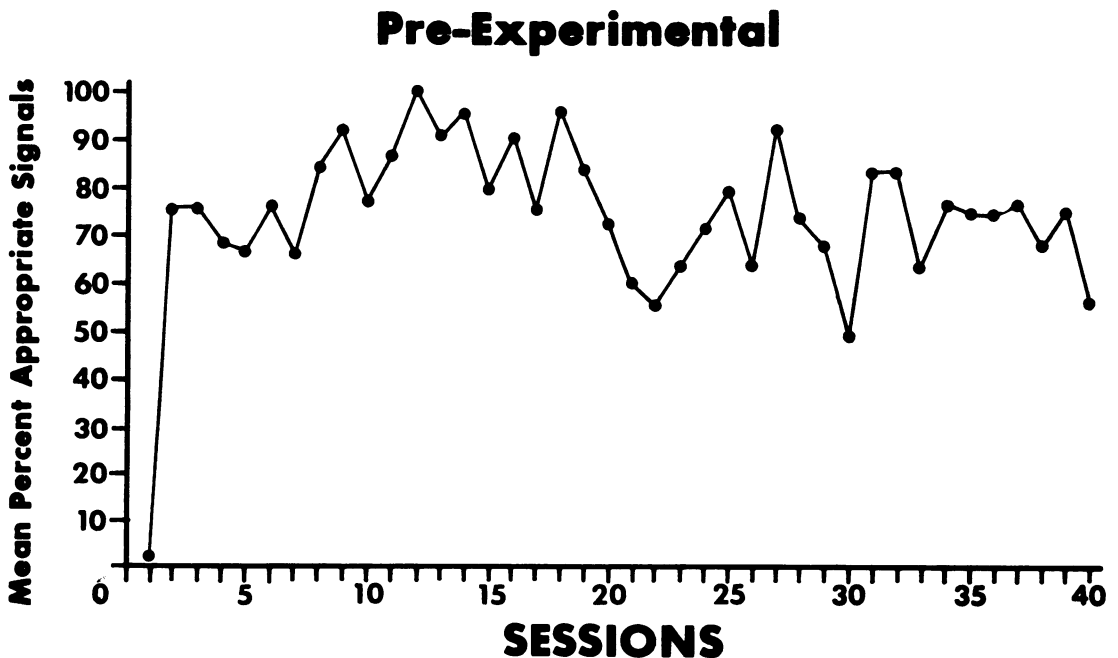


Fig. 1. Pre-experimental data: mean per cent of appropriate signals for 13 teachers.

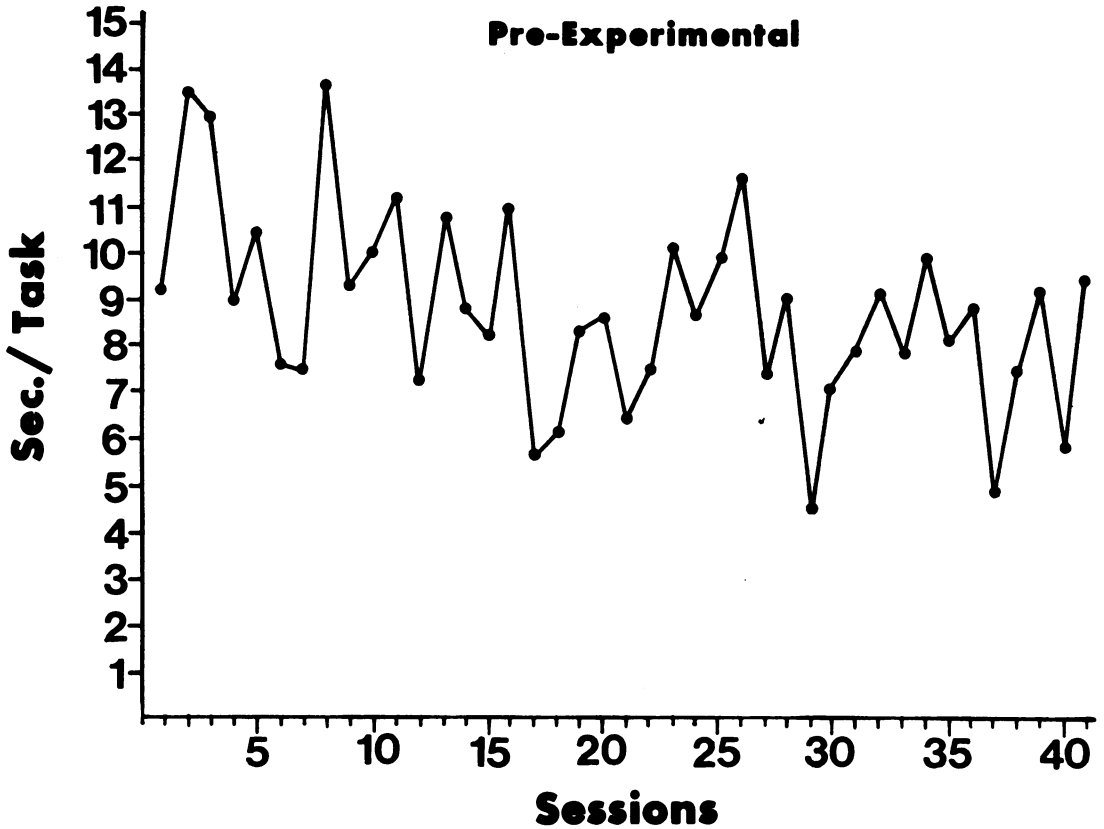


Fig. 2. Pre-experimental data: mean seconds per task for 13 teachers.

Reading I program or in any direct instruction techniques, served as the teachers. The classroom teacher was an employee of a local education agency, and the classroom aides were enrolled in a teacher-training program at the University of Oregon. The classroom aides received university credit for participation in the evaluation study; however, credit was contingent on participation and not on levels of implementation or child performance. Each teacher taught DISTAR Reading I (Engelmann and Bruner, 1974) for 20 min each day to one group of three to five children, in a classroom for developmentally delayed and nondelayed children.

Setting and Materials

All of the training and teaching was conducted in small instructional groups in classrooms at the Center on Human Development, a facility designed to accommodate multiply-hand-

icapped students. The first teacher taught a group of four, nondelayed children, aged 3 to 4 yr, from 9:40 to 10:00 a.m. The second teacher taught a group of five nondelayed 4-yr-old children from 9:40 to 10:00 a.m. And, the third teacher taught a group of 4- and 5-yr-old developmentally delayed children (three Down's syndrome and one moderately language delayed) from 10:00 to 10:20 a.m. Small-group arrangements and supervision were comparable to the conditions in the pre-experimental study.

Experimental Design and Measurement

A multiple-baseline design (Glass, Willson, and Gottman, 1975) was employed to assess treatment effects across the three teachers. The multiple-baseline design was chosen because: (a) the behaviors under study were not considered to be reversible, (b) training resources required that the sample size be limited to three

teachers, and (c) terminal program objectives (*i.e.*, reading instruction) were not compatible with a reversal design.

Measurement. The same measures that were collected in the previous study were collected daily in the present study. Data were collected from both videotape recordings and on-site observations. On-site observers recorded data while viewing the small-group instruction through a one-way window. The videotape recordings of the small-group instruction period were made and rated by the observers later the same day. Since two teachers taught during the same period and only two observers were available, video observations allowed for frequent reliability checks on all teachers.

Percentage agreement and Pearson product moment correlations were used to summarize interobserver reliabilities. The reliabilities in the baseline phase for appropriate signals and seconds per task were: 75% and $r = 0.99$ for Teacher 1, 74% and $r = 0.95$ for Teacher 2, and 81% and $r = 0.99$ for Teacher 3. Reliabilities in the training phase were 87% and $r = 0.99$; 86% and $r = 0.99$; 96% and $r = 0.99$ for the three teachers respectively.

Procedures

Three days before the first day of observation and teaching in the baseline phase, the teachers were instructed to read the *Teacher's Manual for Distar Reading I* (Engelmann and Bruner, 1974) and to familiarize themselves with the teaching materials. Although no training was initiated during the baseline phase, the teacher's manual did discuss signalling and rate of presentation. The teacher's manual was the only source of information on teaching techniques available to the trainees during baseline.

The content of training focused on: (a) the physical arrangement of the setting to optimize participation and reduce distractions, (b) appropriate use of signals, (c) format practice, and (d) increasing the rate of presentation.

Three training procedures were employed to achieve these goals.

1. **Modelling.** The modelling procedure required that the teacher engage in 30 to 45 min of practice each teaching day under the instruction of a supervisor from the Engelmann-Becker Follow Through staff. During this period, the supervisor demonstrated appropriate signalling and rate of presentation and required the trainee to practise the skills in a role-playing situation. Throughout these exercises, the supervisor pointed out areas of skill deficit and attempted to correct deficits by modelling appropriate behaviors and differentially reinforcing successive approximations to the target behaviors.

2. **Practice.** The practice procedure consisted of an assignment of specific practice exercises. The practice exercises were to be completed by engaging in an additional 30 to 45 min of skills practice, at the convenience of the teacher, but before the next teaching day. Any time during training that the small-group performance data or the teacher's performance during modelling sessions indicated that the trainee had not engaged in sufficient practice, additional modelling sessions were scheduled. (Additional modelling sessions were required on only one occasion.)

3. **Feedback.** This procedure required that the trainee view videotapes of herself, recorded during small-group instruction. The teacher was instructed to view the tapes and code her behavior on the same form the observers used.

RESULTS

Figure 3 shows the performance data of each of the teachers on the appropriate signals variable in each phase of the experiment. These data points include both videotape and on-site observation. The observed changes in mean performance from baseline to training were 23.2% to 92.4% for Teacher 1, 26.1% to 97.5% for Teacher 2, and 28.9% to 95.7% for Teacher 3.

Figure 4 shows the performance data for each of the teachers on the seconds-per-task variable. The observed changes in mean performance from baseline to training were 15.6 to 8.5 sec for Teacher 1, 15.8 to 6.6 sec for Teacher 2, and 17.4 to 6.3 sec for Teacher 3.

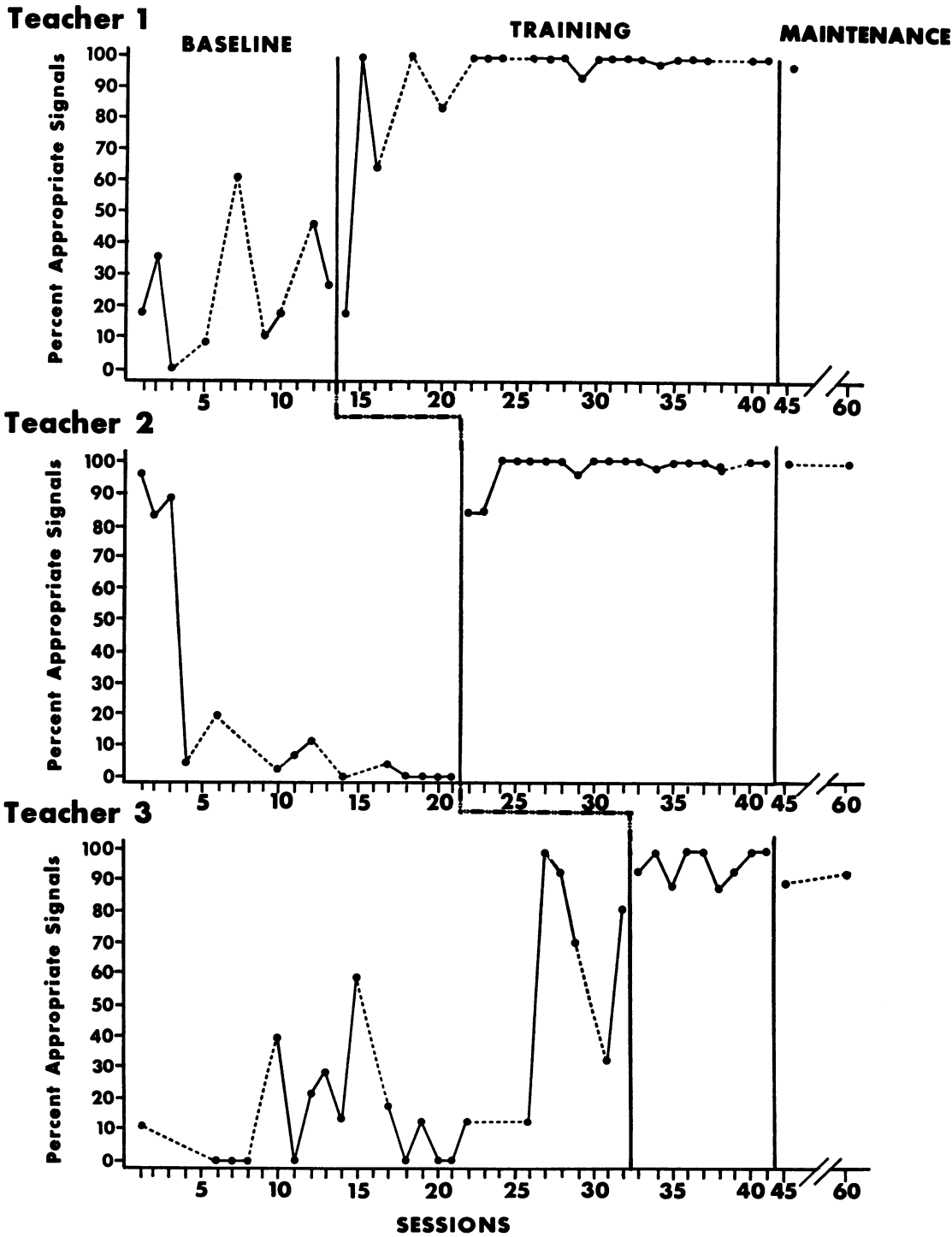


Fig. 3. Per cent of appropriate signals for naive Teach-ers 1, 2, and 3. The broken line indicates a missing data point.

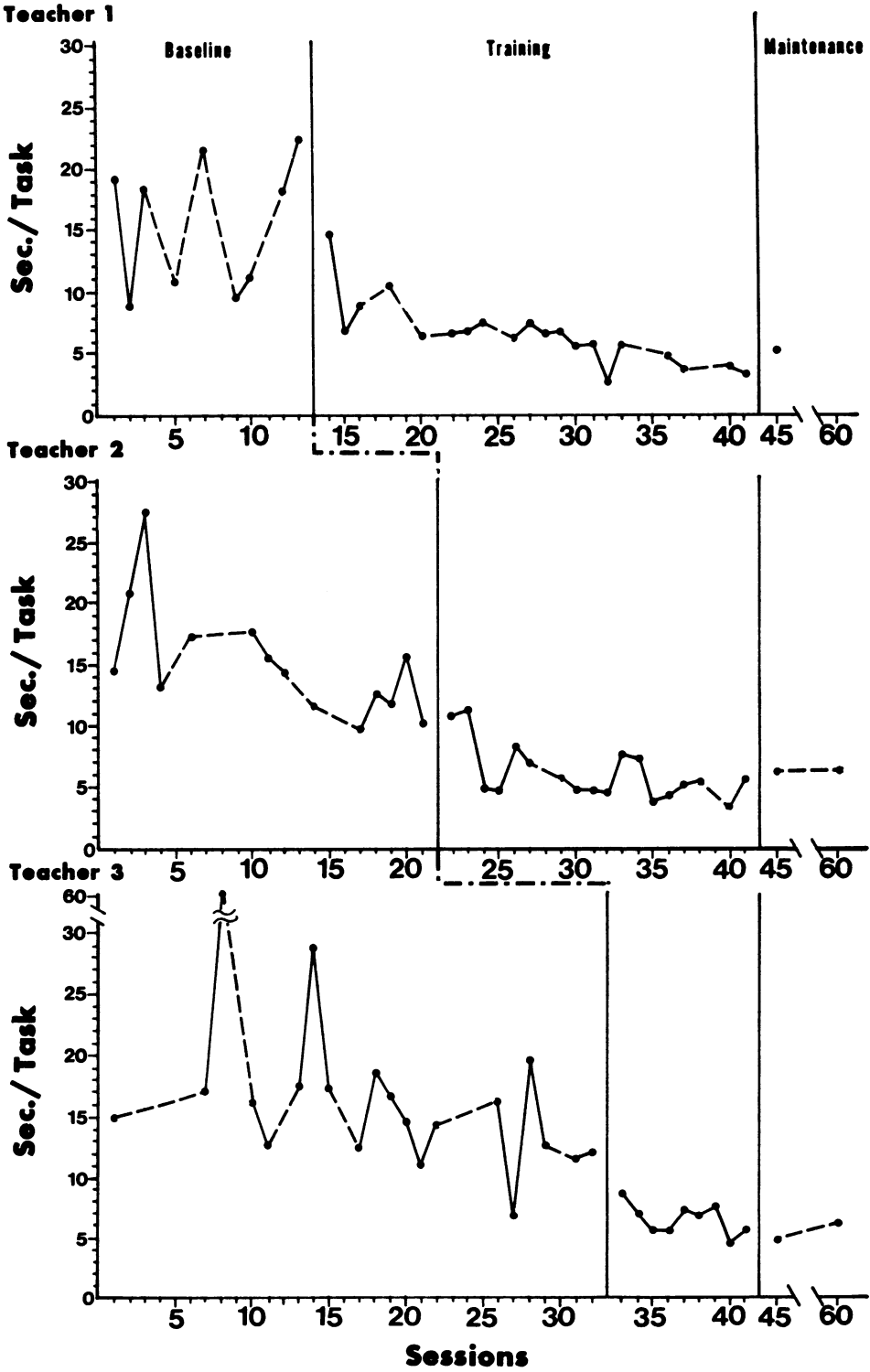


Fig. 4. Seconds per task for naive Teachers 1, 2, and 3. The broken line indicates a missing data point.

Also shown in Figures 3 and 4 are maintenance data collected five sessions and again 20 teaching sessions after training terminated. The maintenance data indicated that the three teachers were signalling appropriately and presenting tasks at levels comparable to those evidenced at the end of the training phase. Teachers 1 and 2 maintained 98% or better appropriate signals and Teacher 3 performed slightly better than 90% appropriate signals. Rate of presentation averaged 6.0 sec per task for Teacher 1, 6.8 sec per task for Teacher 2, and 6.0 sec per task for Teacher 3.

Child achievement data were collected by administering the reading subtest of the Wide Range Achievement Tests (WRAT) four months after the training study terminated. The WRAT data showed that all but one of the 13 children gained at least the expected six months in grade equivalent, and two made gains of 2 yr or more.

GENERAL DISCUSSION

Although the overall effectiveness of the direct instruction model and some component teaching techniques had been demonstrated before these studies, quantitative standards for evaluating program implementation or training were not available. In the present research, the performance of intensively trained teachers was monitored and used as a standard against which the performance of untrained teachers was compared, both before and after training. For signals, the comparison standard was 73.5% appropriate signals; for the untrained teachers, the baseline mean was 26.1%. For rate of presentation, the comparison standard was 8.5 sec per task; for the untrained teachers, the baseline mean was 16.3 sec per task. The contrast between the performance of the trained and untrained teachers indicated that simply reading about signalling and presentation rate in the teacher's guides did not result in adequate technique implementation; that is, direct training was necessary.

A closer inspection of the data, however, indicates that this conclusion needs qualification. Teacher 3 signalled appropriately more frequently beginning in Session 27, before the intervention began. Possibly, the signalling behavior of Teachers 1 and 2 would have improved without training, if training had been delayed. This possibility suggests that signalling improves as a result of practice, with or without training. For example, Teacher 1's signalling behavior improved somewhat during baseline. Similarly, Teacher 2's rate of presentation improved slightly during baseline.

Another question concerning the necessity of training involves Teacher 2, who exhibited a high level of appropriate signalling during the first three baseline sessions. Although all *post hoc* explanations (including this one) are suspect, we feel that two factors contributed to the teacher's performance on those three sessions. First, the teacher had observed the signalling procedure in a class on direct instruction. Second, the novelty effect of a new teacher on young children often produces a brief "honeymoon effect" in which management problems are minimal. Our interpretation is that since Teacher 2 was somewhat familiar with signals, she used them consistently until management problems, many of which resulted from trying to get the children to respond to the signal, became too disruptive. During the first three sessions of baseline, Teacher 2's presentation rate became progressively slower as she attempted to require the students to respond when she signalled. In the fourth session, she gave up on signals and speeded up her presentation.

Even with the qualifications necessitated by the signalling behavior of Teachers 2 and 3, the present data indicate that the training intervention produces clear and immediate effects and that the resultant implementation levels exceed those of the comparison standard. After training, the occurrence of appropriate signals was 95.2%; the comparison standard was 73.5%. The rate of presentation averaged 7.2 sec per task; the comparison standard was 8.5. The 7.2

sec per task was comparable to that of the rapid-rate condition in the Carnine study (1976). The posttraining changes, the favorable comparison of the new levels with the standard, and the maintenance data all indicate that training is feasible.

Although modelling, practice, and feedback have been investigated in other studies (Horton, 1975; Rule, 1972; Saudargas, 1972; Thomas, 1971), the present study has extended the generalizability of the training package to new teacher behaviors. These behaviors are unique, not only because they set the occasion for pupil responses as antecedent events, but also because they occur at a much higher rate than teacher behaviors trained in the previous studies. Presentation rate and appropriate signals involve events that occur every 3 to 5 sec, a rate seldom approached in the training studies that focused on consequences.

The study raises several questions that require further research. Especially important are a set of questions related to cost-effectiveness. How much improvement in technique utilization can be attributed to training (and not to unsupervised practice)? How does this improvement translate into effects on child achievement? Do these achievement effects justify the training costs? (The present study did include a time-saving component that has been incorporated into the direct instruction training program at the University of Oregon—self-critique. While it appears that teacher critiques of audio or videotapes cannot replace supervisor observations and demonstrations, they do reduce the need for supervision.)

The questions about cost effectiveness suggest an extension of the present study to include measures of child performance directly related to training. Achievement gains reported in the present study indicated that the instruction produced acceptable gains; however, the data were not collected so that achievement gains could be parceled out according to the contribution of teacher training. Measures of child performance are also needed in future research to ensure that the

levels identified for the comparison standard are functionally related to child behavior.

A third research question concerns the extent to which different standards are needed for various curricula and classrooms. Although Walker and Hopps (1976) established a restricted comparison norm for students' behavior in a specific classroom, Stallings (1975) discovered a great deal of commonality in technique implementation across subject areas and school districts using the direct instruction program. Future research should seek to determine how standards change as a function of curricula, grade level, and individual student characteristics.

The present findings, combined with those of Siegel (1977), who found that training teachers to correct appropriately child errors is necessary and feasible, provide a limited set of empirically validated teaching techniques and training procedures. As research on teaching techniques continues, the set of effective techniques will expand. The notion of a *set* of techniques is critical because it discourages the teacher educator from training on only one or two techniques (such as signals and pacing) and encourages the teacher educator to consider possible interactions among techniques. For example, we suggested that Teacher 3's emphasis on signals before receiving training slowed her presentation rate. Brophy and Evertson (1976) summarized the notion of a set of techniques in their teacher effectiveness research as follows:

"Effective teaching is not simply a matter of implementing a small number of "basic" teaching skills. Instead, effective teaching requires the ability to implement a very large number of diagnostic, instructional managerial, and therapeutic skills, tailoring behavior in specific contexts and situations to the specific needs of the moment." (p. 139)

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